AMATEUR SATELLITE REPORT

Number 143
February 22, 1987

Editor: Vern Riportella, WA2LQQ
Contr. Editors:
Eric Rosenberg, WA6YBT
Pete Killingsworth, KD7WZ
Paul Roemer, KG6LC
Managing Editor: Bob Myers, W1XT

AMSAT's® *Newsletter for the Amateur Radio Space Program*

Amateur Satellite Report is endorsed by the American Radio Relay League as the special interest Newsletter serving the Amateur Radio Satellite Community

Copyright 1986 by AMSAT®, The Radio Amateur Satellite Corporation. AMSAT® is a registered trademark.

Cold Weather Delays RS Birds and Cosmonauts Launch

The launch of RS-9 and RS-10 is imminent but has been put on a short hold because of the intense cold weather which has gripped Europe and Soviet Central Asia over the past several weeks. Although the Soviets have shown remarkable ability to launch in very cold weather, and indeed several important military payloads have been orbited in recent days, there seems little doubt cold weather is affecting the launch pace.

RS-9 is thought to have a Mode A transponder and a robot aboard. RS-10 carries Modes A, K, T and robot transponders. Frequencies for these transponders were published on page one of *ASR* #140. Monitor the AMSAT nets for the latest news on these new birds. A special launch net will be held on 75 meters the evening of the launch beginning at 0100 UTC.

It is believed the launch will be piggybacked with a Soviet navigational satellite from the major launch site at Plesetsk.

In other Radio Sputnik developments, RS-5 and RS-7 are both back in eclipses. Consequently, they will be out of service entirely until late March. Their batteries are virtually useless and operation in darkness is improbable at best. RS-5 emerges from its eclipse cycle on 28 March while RS-7 completes its cycle on 22 March. After that new schedules may be announced. However, with RS-9 and RS-10 due for launch at any moment, the older birds seem unlikely to garner the attention of either users or controllers for quite a while.

In manned space activity, the Soviet Union is turning a new page in their highly successful manned space program. The launch of a Progress 27 cargo ship on 16 January was followed by its successful docking to the Mir Space Station on 18 January. Although it had been expected 3 Cosmonauts would be launched soon after the successful docking, they had not been launched to orbit by Saturday, 31 January. According to the Associated Press, the Soyuz TM-2 launcher had been fueled and was sitting on the pad ready for launch on Friday, 30 January. The cold weather at the Baikonur Cosmodrome was thought to have caused the delay.

It appears the first major launch window for docking has been missed, according to K1KSY. The next window appears to be in late February unless further substantial maneuvers of the Mir Space Station are implemented. In recent days Mir's orbit has been notably changed. For example, on 19 January it was 345 X 317 km whereas by 26 January it had been raised to 371 X 337 km. Both inclination and eccentricity were essentially unchanged by the maneuvers performed during that week.

Soviet television showed mission commander Yuri Romanenko and rookie Cosmonaut Alexander Laveikin undergoing final preparations for the flight in the Soyuz TM-2 spacecraft, a new generation capsule that will take them to Mir. The Mir, which means "Peace" in Russian, has been unmanned since cosmonauts Leonid Kizim and Vladimir Solovev returned from orbit last 16 July.

The Cosmonauts will stay aboard Mir for 290 days. However, according to the authoritative trade journal Aviation Week & Space Technology, the present manned space mission will mark the beginning of a permanent Soviet manned presence in space aboard Mir and the modules subsequently docked to it.

The first science module is being prepared for launch according to *Aviation Week*. It is an astrophysics laboratory, the magazine said.

AMSAT OSCAR 10 To QRT For Two Months In March and April

The good operating time on AMSAT OSCAR 10 continues. Considering the gloomy prospects satellite users faced last autumn, these bonus times on AO-10 must be doubly enjoyable to users world-wide.

The key to AO-10's afterlife remains the excellent work of the command team together with a growing spirit of cooperation among the world's user community. Apparently word is getting out that careful use of AO-10 will extend its tenuous grasp on life.

The stewardship of the spacecraft's health is shared among controllers and analysts. In a recent analysis by James Miller, G3RUH, (elsewhere in this edition of *ASR*) he

6th Anniversary Issue

showed how sun angles vary throughout the balance of the year. It's apparent from Jim's analysis that there will be insufficient power available beginning in March and lasting through April. Consequently, AO-10 operations must be suspended for that two-month period. Given general cooperation, AO-10 will again be released for operation May through August. In order for AO-10 to be available for use beginning again in May, however, it is absolutely essential to preserve battery health. Given the very poor sun angles extant during March and April, the only way to assure battery health is to not use the bird during March and April. According to G3RUH, solar illumination will plummet to only 7% in late March and average under 30% for the entire 2 month period.

By 23 February, the spacecraft attitude had changed to 149 longitude and +12 latitude in the Bahn coordinate system, according to G3RUH's analysis. Best operating times are before apogee.

Mode B use is permitted through 28 February. Do not use AO-10 during March and April. QRP use is essential. That means 100 watts ERP or less please. Operating is permitted from MA 21 through 219 only. Continuous carrier emissions such as RTTY, SSTV, FM and full-carrier AM are prohibited henceforth because of limited available power. (FM and AM have always been prohibited).

Watch for AO-10 condition reports and operating advice via all the usual satellite news sources.

AMSAT Net Frequencies Under Review; Changes Expected

AMSAT NA net frequencies and times are under review according to Vice President of Operations, Ralph Wallio, WØRPK. In particular, changes to the 75 meter frequency can be expected very soon, according to Ralph. A primary consideration in choice of frequency is the effectiveness of the net in conveying vital operations information. This, he says, has suffered in increasing proportions recently because of increasing band occupancy in the usual gathering place, 3857 kHz.

Consequently, the AMSAT NA 75 meter nets (Tuesday evenings local time) will immediately move to the Advanced portion of the 75-meter band (below 3850 kHz). The exact nominal frequency of the net is pending a survey being performed by WØRPK, WØCY and W8GQW. Until the results are tabulated, the net will set up shop on 3840 ±10 kHz. Later it is anticipated the net will move lower in the band, perhaps down to the vicinity of 3820 kHz. In any case, WØRPK advises net participants to tune the portion of the band from 3850 DOWN to find the net beginning with the net session of Tuesday evening, 3 February.

In related news, *Amateur Satellite Report* will be publishing a complete net roster as soon as editors are assured the listing is current and accurate. Therefore, if you are an net manager or net control station and wish your AMSAT net listed on AMSAT NA's master net roster, please communicate the details of that net prior to February 28 to AMSAT NA Headquarters, P.O. Box 27, Washington, D.C. 20044. Local and regional nets as well as the major nets are sought for inclusion in the roster.

Likewise, overseas net managers are cordially invited to submit details of their net activities as well for inclusion in the master net roster. Copies of the roster will be made available to all AMSAT societies and members free of charge once issued.

AN OSCAR-10 ALMANAC 1987

by James Miller G3RUH

The satellite can no longer be automatically controlled by on-board software due to damaged memory. Nevertheless, AO-10's life can be extended by sensitive usage to ensure maximum battery health. This table enumerates the relevant factors. Why not keep a copy beside your station?

1987 Date Monday	Arg Peri AP	Sun's Pos'n SAZ SEL	Spacecraft Attitude ALON ALAT	Best MA MINsq	Solar Illum. SA ILL/	Eclipse Data MA MA Dur In Out Mins	Recommended Use MA-MA
Jan 5	174	72 2	154 15	75	7 99	220 240 54	Jan
Jan 12	176	78 4	154 14	73	15 97	224 242 50	---
Jan 19	178	84 6	153 14	72	22 93	227 244 45	20 - 200
Jan 26	180	90 8	152 13	70	29 88	231 246 42	
Feb 2	181	96 10	151 13	69	36 81	233 247 39	Feb
Feb 9	183	102 11	150 12	68	43 73	236 249 36	---
Feb 16	185	109 12	150 12	66	50 64	238 250 34	20 - 220
Feb 23	187	115 13	149 12	65	57 54	240 251 32	
Mar 2	189	121 13	148 11	64	64 44	241 252 31	
Mar 9	191	128 14	147 11	63	71 33	243 253 30	
Mar 16	193	134 13	146 10	61	78 21	244 254 29	Mar/Apr
Mar 23	195	140 13	145 10	60	84 10	245 255 29	------
Mar 30	196	147 12	144 9	59	86 7	246 0 28	D O
Apr 6	198	153 11	144 9	58	80 17	247 1 28	N O T
Apr 13	200	159 10	143 8	57	74 28	248 2 28	U S E
Apr 20	202	165 9	142 8	56	67 39	249 3 28	
Apr 27	204	171 8	141 7	54	60 50	250 4 28	
May 4	206	177 6	140 7	53	54 59	250 5 28	
May 11	208	183 5	139 6	52	47 68	251 5 28	
May 18	210	189 3	138 6	51	40 77	252 6 28	
May 25	211	194 2	138 5	50	33 84	253 7 28	May/Jun
Jun 1	213	200 1	137 5	49	27 89	253 8 29	------
Jun 8	215	206 -1	136 4	48	20 94	254 9 29	30 - 220
Jun 15	217	212 -2	135 4	47	13 97	255 10 30	
Jun 22	219	217 -3	134 3	46	7 99	0 11 30	
Jun 29	221	223 -4	133 3	45	0 100	1 12 31	
Jul 6	223	229 -4	132 2	44	-7 99	2 13 32	
Jul 13	225	235 -5	131 2	44	-13 97	2 15 33	
Jul 20	227	241 -5	131 1	43	-20 94	3 16 34	
Jul 27	228	247 -5	130 1	42	-27 89	4 18 36	Jul/Aug
Aug 3	230	252 -5	129 0	41	-33 83	6 19 37	-------
Aug 10	232	258 -5	128 0	40	-40 76	7 21 39	40 - 220
Aug 17	234	264 -4	127 -1	39	-47 68	8 23 42	
Aug 24	236	270 -4	126 -1	39	-54 59	10 26 44	
Aug 31	238	276 -3	125 -2	38	-60 50	12 29 47	
Sep 7	240	282 -2	124 -2	37	-67 39	14 32 51	
Sep 14	242	288 -1	124 -3	36	-74 28	16 36 54	
Sep 21	243	294 0	123 -3	36	-80 17	19 40 59	Sep/Oct
Sep 28	245	300 1	122 -4	35	-86 7	22 45 63	-------
Oct 5	247	306 2	121 -4	34	-84 10	26 51 68	D O
Oct 12	249	312 2	120 -5	34	-78 21	30 57 73	N O T
Oct 19	251	318 3	119 -5	33	-71 32	36 64 77	U S E
Oct 26	253	324 4	118 -6	32	-64 43	43 73 81	
Nov 2	255	330 4	118 -6	32	-58 54	52 83 84	
Nov 9	257	336 5	117 -7	31	-51 64	61 93 86	
Nov 16	258	342 5	116 -7	31	-44 73	74 106 88	Nov/Dec
Nov 23	260	349 5	115 -8	30	-36 80	86 119 90	-------
Nov 30	262	355 5	114 -8	30	-29 87	100 134 93	Await
Dec 7	264	1 4	113 -9	29	-22 93	114 149 96	further
Dec 14	266	8 4	112 -9	29	-15 96	127 164 99	notice.
Dec 21	268	14 3	112 -10	28	-8 99	141 178 101	
Dec 28	270	20 2	111 -10	28	-1 100	153 190 99	

ANALYSIS:

First, illumination runs cyclically up and down from almost NIL to 100%. NEVER use the satellite when illumination is less than 50%. This requires total abstinence during MARCH and APRIL and again during SEPTEMBER and OCTOBER.

Second, the spacecraft's pointing favors operation well before apogee, so that ranges will often be 1/2 apogee distance. That's worth 12 dB, i.e. a massive 16 fold link improvement, so go easy on the power! You'll find 10 - 100 watts EIRP should frequently be entirely adequate.

Finally, the satellite experiences eclipses every orbit in 1987. NEVER use the satellite during an eclipse and allow time for battery recovery, especially towards year's end.

DETAILED EXPLANATIONS:

ILLUMINATION. The most important parameter of all. "SA" is the Sun Angle, between the Sun and solar panels, and "ILL", Illumination = 100*Cos(SA). Unfortunately the spacecraft's spin axis lies almost exactly in the Sun's orbit plane, so illumination dips to near zero every 180 days. The electrical power balance is precarious at that time, so DO NOT USE THE TRANSPONDER.

ECLIPSES. "MAin" and "MAout" are the mean anomalies (/256) of entry and exit into solar eclipse. "Dur" is the duration in minutes. As the batteries receive no power, DO NOT USE THE TRANSPONDER during an eclipse. Eclipses are short at the start of the year but from mid-September onwards become considerable. Batteries will then require a longer recovery time especially during poor Sun angles such as in Sept/Oct.

SUN POSITION - (degrees). "SEL" is Solar Elevation above or below the orbit plane. Its small value reflects the fact that the satellite and Sun's orbital planes are closely aligned (closest Sept. 24), so that eclipses occur on every orbit. "SAZ" is solar azimuth around the plane. Zero (0) degrees aligns with perigee increasing in the same direction as AO-10's orbital motion. When the value is similar to (180 degrees from) the direction of the spacecraft's antennas (e.g. March 30, September 28), illumination is minimum. In May, the Sun aligns with apogees which will be midday centered, whereas those of December are midnight centered.

ATTITUDE (degrees). Attitude is described by the direction of the motor (i.e. spin) axis and is expressed as a longitude and latitude in the same sense as solar azimuth and elevation (as above). The antennas of course point the opposite way, towards (ALON+180 and -ALAT), such that when ALON=180 and ALAT=0, the antennas point at Earth's center from apogee. AO-10's attitude can no longer be manipulated by ground command. It is thus essentially fixed in space forever. As the orbit plane changes, the values given in the table will be realized. The minimum misalignment from the Earth's center occurs at "MINsq", minimum squint and is presented in the table in terms of MA (/256) at which the the misalignment is least. Best transponding will be centered about this MA. The value of minimum misalignment itself is given by "ALAT" and is sensibly small throughout the year, gradually favoring the Northern Hemisphere. May/June/July should prove outstanding.

AO-10 / EARTH MODEL
1987 UPDATE & SMOOTHED EPHEMERIS

Here are equations for AO-10's mean anomaly (MA), longitude of ascending node (LAN), argument of perigee (AP), right ascensions of ascending node and Greenwich Hour Meridian (RAAN & GHAA) referred to 1987, Day 0, equivalent to 1986 Day 365 or 1986 Dec. 31 0000:00 UTC. Smoothed Keplerians however are referenced to 1987 Jan. 01 @ 0000 UTC.

These may be used with my orbit model (OSCAR News 44 et seq.) or simply for day to day calculations such as orbit number and MA. They have been derived by smoothing three month's worth of NASA Keplerian elements. Uncertainties are 0.1 degrees RMS with respect to the very noisy source data and will hold accurately enough for practical purposes throughout 1987.

Ephemeris for AO-10, 1987 Day 0
MA = 319.8 + 741.1624 x TIME deg
LAN = 56.4 + 361.1458 x TIME deg W
(LAN = GHAA - RAAN)
AP = 172.6 + 0.2680 x TIME deg

Additional data:
RAAN = 42.7 - 0.1602 x TIME deg E
GHAA = 99.1 + 360.9856 x TIME deg E

where TIME is the time of the year, in days, e.g.
TIME = 1.5 days = 1987
Jan 01 @ 1200 UTC. Orbit number at TIME = 0 is 2668.

SMOOTHED KEPLERIAN ELEMENTS:

Epoch Time: (1987 Jan 1st @ 0000UTC)	1987 Day 001 UTC
Inclination	27.00 deg
RA of Node	42.54 deg East
Eccentricity	0.603 -
Arg of perigee	172.91 deg
Mean Anomaly	340.98 deg
Mean Motion	2.0587846 rev/day
Decay Rate	0 rev/day/day
Epoch Rev	2670 rev
Semi major Axis	26105.3 km

SHARP PC1245 DATA:

G=3285.56849, N=12.935725, I=27.0, O=42.77,
W=172.52, E=0.6, A=4.09293, Q=-0.1602,
V=0.2680, F=360.985647
(Note: G = 1986 Dec. 30 @ 1338:37.5 UTC)

Flight Version IHU Up and Running

Gordon Hardman, KE3D, says the Phase 3C flight Integrated Housekeeping Unit (IHU) has been powered up and is running perfectly. He says he was a little nervous about handling the nearly $100,000 in specially radiation hardened integrated circuits which were installed on the board but after it was powered he found everything in order. The timing margins provided by W2FPY's design were excellent, Gordon says.

The IHU comprises a special Sandia COSMAC 1802 CPU and the Harris HS6564RH memory chips and supporting circuitry. Harris donated the memory late last year in an effort begun by KB2M last summer to acquire the superhard CMOS devices. This effort was spurred on by the deteriorization of AO-10's memory last autumn.

The delay in P3C launch caused by the slip in the Ariane launcher schedule has provided the slack necessary to prepare this new IHU. It is nearly two orders of magnitude harder than the AO-10 IHU. In addition, special tungsten appliques were donated by Ross Forbes, WB6GFJ, for the new IHU. These further increase the IHU and supporting circuit hardness. The tungsten appliques are even denser than the tantalum covers used on AO-10 and the Phase 3A IHUs.

Additional space-qualified CMOS ICs were donated by RCA Solid State Division, Somerville, N.J. The RCA donation was arranged by Ivars Lauzums, KC2PX. Ivars is an active VHFer and proprietor of the PX Shack in Southern N.J.

Board layout and artwork was done by Andy Deskur, KA1M.

Obtaining Tracking Data

ASR publishes Keplerian elements for tracking the popular satellites as frequently as practical. Recently, "practical" has been about every 5th issue, ie, *ASR* – 131, 137, 142. This is not frequent enough for some and too frequent for others. There are several alternative solutions available to you if you require more frequent updates:

1. You can pick up the data on the AMSAT nets.

2. You can check into WØRPK's computer bulletin board at 515-961-3325 (See *ASR* #128).

3. You can send an SASE to AMSAT NA (P.O. Box 27, Washington D.C. 20044) for a free copy of the latest.

4. You can check into a packet radio bulletin board which offers the elements on file.

5. You can copy the elements from UO-11.

6. For AO-10 in particular, you can use G3RUH's smoothed emphemeris (see this issue) for a set which will be usable for at least 6 months.

Short Bursts

• The AMSAT Phase III Satellite Operations Manual is being updated to include information on Phase 3C. Project Leader John Champa, K8OCL, says the new editions should be off the presses in time for the Dayton Hamvention in late April. The Manual is a joint effort of AMSAT NA and project OSCAR and was first published in 1985.

First Class Postage Correction

In *ASR142* we mentioned AMSAT is considering a first class *ASR* mailing option for domestic members. The amount should have been $6/year.

AMSAT®

The Radio Amateur Satellite Corporation

Post Office Box 27
Washington, DC 20044
(301) 589-6062

In Arizona W8GQW surveys his AO-10 antenna system. The KLM-14C and 435-40CX antennas are located at ground level and each fed with 100 feet + of 9913 coax. At upper left a rock which serves as counter balance and is not rf sensitive! At lower left the tripod supports an enclosure containing an ARR 2M GaAsFET preamp and power supply plus power supplies for both of the antenna polarity switchers.

Non-Profit Organization Second Class POSTAGE PAID at Waterbury, Conn.

LM-1096 KA6M 99.81
MAGNUSKI, HANK
2019 BARBARA DR.
PALO ALTO CA 94303

Amateur Satellite Report (ISSN 0889-6089) is published biweekly for $16 (inseparable from annual membership dues of $24) by AMSAT, Post Office Box 27, Washington, DC 20044. Second class postage paid at Silver Spring, MD and additional mailing offices. POSTMASTER: send address changes to *Amateur Satellite Report*, Post Office Box 27, Washington, DC 20044.